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ABSTRACT

This study was designed to investigate the relationship between wait-time and two classroom interaction variables: cognitive level of teacher questions and length of student response. The interval of time between a teacher question and the next verbal response by teacher or student (wait-time) was measured using an electrocardiograph with calibrated paper connected to an audiotape recorder. Students taught to categorize and graph their own questioning behavior increased the rate at which they asked high-level questions. The wait-time for experimental subjects increased and was directly related to the length of student response. Control subjects did not show these changes. (Author)

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Classroom Interaction Patterns During Microteaching: Wait-Time As An Instructional Variable

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Studies examining the verbal interaction of teachers and students in the classroom have revealed a strikingly similar pattern of discourse regardless of the grade level or the subject matter taught. The pattern is characterized by rapid-fire question and answer sequences with the questions nearly always coming from the teacher. Even in science programs specifically designed to foster the "inquiry" approach, the quality of discourse tends to be at a low level and the verbal interaction is more remindful of an inquisition than a joint investigation or conversation.

Rowe (1972)[1] recorded examples of science instruction from classrooms in urban, suburban, and rural areas. She found that, although different curricula were used as the medium of instruction, with the exception of a few individuals (three in 200 recordings), the pace of instruction was very rapid.

Teachers allowed pupils an <u>average</u> time of only one second to start an answer to a question. If they did not begin a reply within one second, teachers usually either repeated the question or called on others to respond. When pupils did respond, teachers usually waited slightly less than a second (average of 0.9 seconds) before commenting on the response, asking another question, or moving to a new topic.

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[1] Rowe, Mary Budd. "Wait-time and Rewards as Instructional Variables: Their Influence on Language, Logic, and Fate Control." Paper presented at the meeting of the National Association for Research in Science Teaching, Chicago, Illinois, April 1972.

Data indicated a relationship between longer wait-times, slightly in excess of three seconds, and such desired inquiry behaviors as pupil discourse marked by conversational sequences, alternative explanations, and arguments over the interpretation of data.

In addition, Rowe found that the pattern of behavior the teacher exhibited when working with four children closely resembled the pattern displayed when teaching an entire class. The fact that size ofgroup does not seem to influence the nature of classroom interaction patterns makes microteaching a suitable research tool for examination of this variable.

Rowe manipulated wait-time as an experimental variable using groups of four elementary school pupils in fifteen-minute micro-teaching sessions. A servo-chart plotter with calibrated paper was used to measure intervals of silence. Transcripts were analyzed to determine whether the pattern of question asking spontaneously changed as a result of increase in wait-time. The Ashner and Gallagher, and Parsons categories were utilized. For those teachers who attained and sustained the criterion wait-time of three seconds or more, it was found that the mean number of questions decreased. The percentage of informational questions (low level) decreased while the percentage of leading and probing questions (high level) increased. The proportion of rhetorical questions remained about the same.

Rowe found that an increase in length of wait-time to three seconds or more resulted in the following student outcome variables:

1. <u>The length of student responses increased</u>. Under a fast schedule, responses tend to consist of short phrases and rarely exhibit explanation of any complexity.
2. <u>The number of unsolicited but appropriate student responses increased</u>.

3. Failures to respond decreased. "I don't know" or no responses were often as high as 30% in classrooms where the mean wait-time fell at one second or less.
4. Confidence as reflected in fewer inflected responses increased. Under a fast schedule, responses tend to be phrased as though the child were saying, "Is that what you want?"
5. The incidence of speculative thinking increased.
6. Teacher-centered show and tell decreased and student-student comparing increased.
7. More evidence followed by or preceded by inference statements occurred.
8. The number of questions asked by children increased and the number of experiments they proposed increased. Students rarely ask questions and when they do the questions are usually for clarification of procedures.
9. "Slow" student contributions increased. Under a fast schedule most responses came from a particular faction of the class. When wait-times were increased, the number of students responding increased.

The purpose of this study was to determine whether changes in teacher questioning behavior would result in spontaneous changes in wait-time. It was hypothesized that an increase in the number of high-level questions asked would be accompanied by an increase in wait-time. The assumption was made that high level questions require more thoughtful and detailed responses than low level questions and thus wait-times would need to be longer if such questions were to be answered appropriately. High level questioning resulted

in more lengthy student responses and in more student-student interchange should result in an increase in the amount of pupil talk.

The subjects in the study[2] were twenty University of Minnesota College of Education juniors who were enrolled in a five-credit course in educational psychology and a one-credit science methods course. The group was composed of sixteen males and four females. One-half were preparing to teach in the physical sciences (chemistry, physics, and earth science), the other half in the biological sciences.

Subjects were randomly assigned to one of three treatment groups: a control group (C) of six and two experimental groups (E1 and E2) of seven subjects each.

Each subject taught a unit of ten, ten-minute micro-lessons on one of three assigned topics from the physical sciences: color, heat transfer, or simple machines. Each subject taught the same group of four seventh graders or six eight graders for each lesson. Subjects were given a short description of the types of concepts that could be covered within their assigned topic. Demonstrations and experiments were encouraged, but students were given complete freedom to plan their own series of lessons. Each lesson was audiotaped and subjects were assigned a time in which to listen to the audio playback of their lessons.

Following the first five micro-lessons, the first experimental group (E1) of seven subjects received the experimental treatment, which consisted of a forty-five minute training session focused on questioning behavior. Following the seventh lesson, the second experimental group (E2) of seven subjects participated in an identical training session. The third group of six subjects served as a control group (C) and did not participate in the training session.

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[2]Boeck, Marjorie A. Experimental Analysis of Questioning Behavior of Pre-Service Secondary School Science Teachers. Ph.D. Dissertation. University of Minnesota, December 1970. (Unpublished).

During the forty-five minute training session, subjects were taught to categorize questions according to definitions derived from the Bloom taxonomy. Low level questions were classified as those requiring simple memory or translation while high level questions were those involving application, analysis, synthesis, or evaluation.

Subjects were told to concentrate their teaching efforts in the remaining microteaching sessions on asking questions of their pupils which required more than rote memory for a correct response. During the training sessions, students were reminded that because high-level questions require the student to combine pieces of knowledge in order to formulate an answer, the length of time the teacher must pause before reasonably expecting a response is greater than if a low-level question had been asked. They were asked to categorize their questioning behavior using the audiotape of their daily lesson and to graph the frequency of high level questions asked during each teaching period.

Typescripts of all teacher questions were made from the audiotapes to facilitate the categorization process. For the final analysis, the five categories were collapsed into two categories (low level and high level). The number of high level questions asked was divided by the number of minutes taught to obtain the rate of high level questions asked per minute. The same procedure was followed to obtain the rate of low level questions asked per minute. Electric timers were used to measure the rates of pupil and teacher talk in seconds per minute.

Information about the effectiveness of the treatment for individual subjects was obtained by studying graphs for each subject which showed the rates for each of the four variables for each of the ten lessons.

A comparison of individual subject graphs indicated the treatment was not equally effective for all experimental subjects. In general, the rates of high level questioning and pupil talk increased while the rate of teacher talk decreased. No consistent pattern was observed for the rate of low level questioning following treatment. No clear changes in rates were observed for the control subjects. The results of the individual subject analysis were substantiated by group analyses of the data.

The wait-time or length of pause after a teacher-initiated question was determined from the audiotape recordings utilizing an EKG machine with calibrated paper. For this analysis, the lessons from fourteen of the original twenty subjects were randomly selected. Four subjects were from the control group, four from the first experimental group (E1), and six from the second experimental group (E2).

For each subject, the mean wait-time following low level questions and the mean wait-time following high level questions was measured for each day and for the total number of sessions. Pre- and Post-treatment mean wait-times were calculated for the experimental subjects.

The frequencies and percentages of low level, high level, routine (procedural), and rhetorical questions were determined. In addition, the proportion of questions to which the students did not respond and whether these questions were of low or high level was examined. These data are summarized in Tables I-IX.

Analysis of the audiotapes of lessons taught by both control and experimental group subjects did not reveal the often reported patterns of rapid-paced questioning with wait-times averaging one second or less. This might be a result of the topics covered during their educational psychology course prior to microteaching. The importance of giving students sufficient time to respond to questions and positive reinforcement for responding was discussed.

The control subjects asked relatively few high level questions and this rate was stable across all ten sessions. Following treatment, experimental subjects asked more total questions with a larger proportion categorized as high-level. The number of rhetorical questions decreased following treatment.

In nearly all instances, the wait-time following high-level questions both before and after treatment was greater than that following low level questions. Because nearly all wait-times exceeded Rowe's three second criterion, the effect of the treatment on wait-time is less clear.

The frequency of questions to which there was no student response appeared to be more a function of the individual teacher than of the type of question asked or the experimental treatment. However, high-level questions more frequently were unanswered than low level ones. In no instance, did the rate of no response reach the thirty percent level reported as being typical of classroom discourse patterns.

It was found that the longest pauses (ranging from 3.68 to 42.32 seconds) occurred when the subjects asked high-level questions to which the students did not respond.

The pattern following such a failure to respond varied with the teacher. Some teachers generally repeated a variant of the same question. Other teachers, apparently sensing that no students could at that moment answer the question, did not repeat the same question, but rather asked the students a series of questions at the memory level designed to remind them of the factual information needed to answer the original question. Students were then able to answer the high-level question correctly.

Wait-times following this type of low level question were generally longer than wait-times following memory questions designed to review (quiz) the

students on the previous lesson's material.

In some instances the wait-time interval appeared to be related more to the length of response required by the students than to whether the question was categorized as high or low level.

In summary, there is a relationship between the type of teacher question asked and the wait-time before a response is given. In general, wait-times are longer for high-level questions. However, the actual pause length was dependent on such variables as length of response required, question difficulty and length, and whether or not the students responded.

TABLE I: Percentages of Teacher Question Types
Control Subjects

Subject	Low Level	High Level	Rhetorical	Routine
C-2	38	22	9	32
C-4	42	20	15	23
C-5	38	12	13	37
C-6	47	11	26	16

TABLE II: Percentages of Teacher Question Types
Experimental Subjects Before Treatment

Subject	Low Level	High	Rhetorical	Routine
E1-1	6	35	34	24
E1-2	35	18	8	39
E1-3	43	21	21	14
E1-4	33	26	18	23
E2-7	41	32	10	16
E2-8	47	10	16	26
E2-9	50	21	9	19
E2-10	38	20	6	36
E2-11	58	27	9	7
E2-12	36	28	8	28

TABLE III: Percentages of Teacher Question Types
Experimental Subjects After Treatment

Subject	Low Level	High Level	Rhetorical	Routine
E1-1	34	33	9	24
E1-2	42	14	6	38
E1-3	33	41	16	10
E1-4	40	40	5	15
E2-7	33	43	5	20
E2-8	61	14	10	15
E2-9	29	46	6	20
E2-10	33	35	11	21
E2-11	23	67	2	7
E2-12	34	41	9	16

TABLE IV: Questions to Which Students Did Not Respond
Control Subjects

Subject	Low Level	High Level	% of Total Questions
C-2	5	6	6
C-4	7	3	8
C-5	1	--	1
C-6	3	2	3

TABLE V: Questions to Which Students Did Not Respond
Experimental Subjects Before Treatment

Subjects	# Low Level	# High Level	% of Total Questions
E1-1	--	4	6
E1-2	1	4	10
E1-3	1	--	4
E1-4	--	--	--
E2-7	2	1	2
E2-8	1	--	1
E2-9	--	1	1
E2-10	--	1	2
E2-11	3	--	3
E2-12	--	--	--

TABLE VI: Questions to Which Students Did Not Respond
Experimental Subjects After Treatment

Subjects	# Low Level	# High Level	% of Total Questions
E1-1	2	8	7
E1-2	2	2	6
E1-3	1	2	4
E-1-4	3	--	2
E2-7	--	--	--
E2-8	1	--	1
E2-9	--	1	1
E2-10	1	--	1
E2-11	--	2	2
E2-12	--	5	7

TABLE VII: Mean Wait-Time Following Questions
Control Subjects

Subjects	Low Level Questions		High Level Questions	
	Time (Seconds)	N	Time (Seconds)	N
C-2	3.35	71	5.78	40
C-4	4.10	49	5.74	24
C-5	1.12	46	2.23	14
C-6	5.75	82	10.32	19

TABLE VIII: Mean Wait-Time Following Questions
Experimental Subjects Before Treatment

Subjects	Low Level Questions		High Level Questions	
	Time (Seconds)	N	Time (Seconds)	N
E1-1	2.28	4	6.57	22
E1-2	3.41	18	6.34	9
E1-3	6.79	12	4.99	6
E1-4	2.72	44	3.43	35
E2-7	2.44	72	4.72	57
E2-8	2.66	70	4.03	15
E2-9	2.81	59	3.74	25
E2-10	3.46	25	7.59	13
E2-11	6.05	60	1.4	28
E2-12	2.26	50	2.39	38

TABLE IX: Mean Wait-Time (Seconds) Following Questions
Experimental Subjects After Treatment

Subjects	Low Level Questions		High Level Questions	
	Time (Seconds)	N	Time (Seconds)	N
E1-1	3.20	48	5.41	46
E1-2	3.53	30	4.57	10
E1-3	3.09	27	4.03	33
E1-4	2.57	51	2.53	51
E2-7	2.30	45	2.44	59
E2-8	2.94	63	2.20	15
E2-9	2.68	31	3.03	49
E2-10	2.23	27	2.71	29
E2-11	1.69	20	2.41	58
E2-12	4.58	23	5.93	28